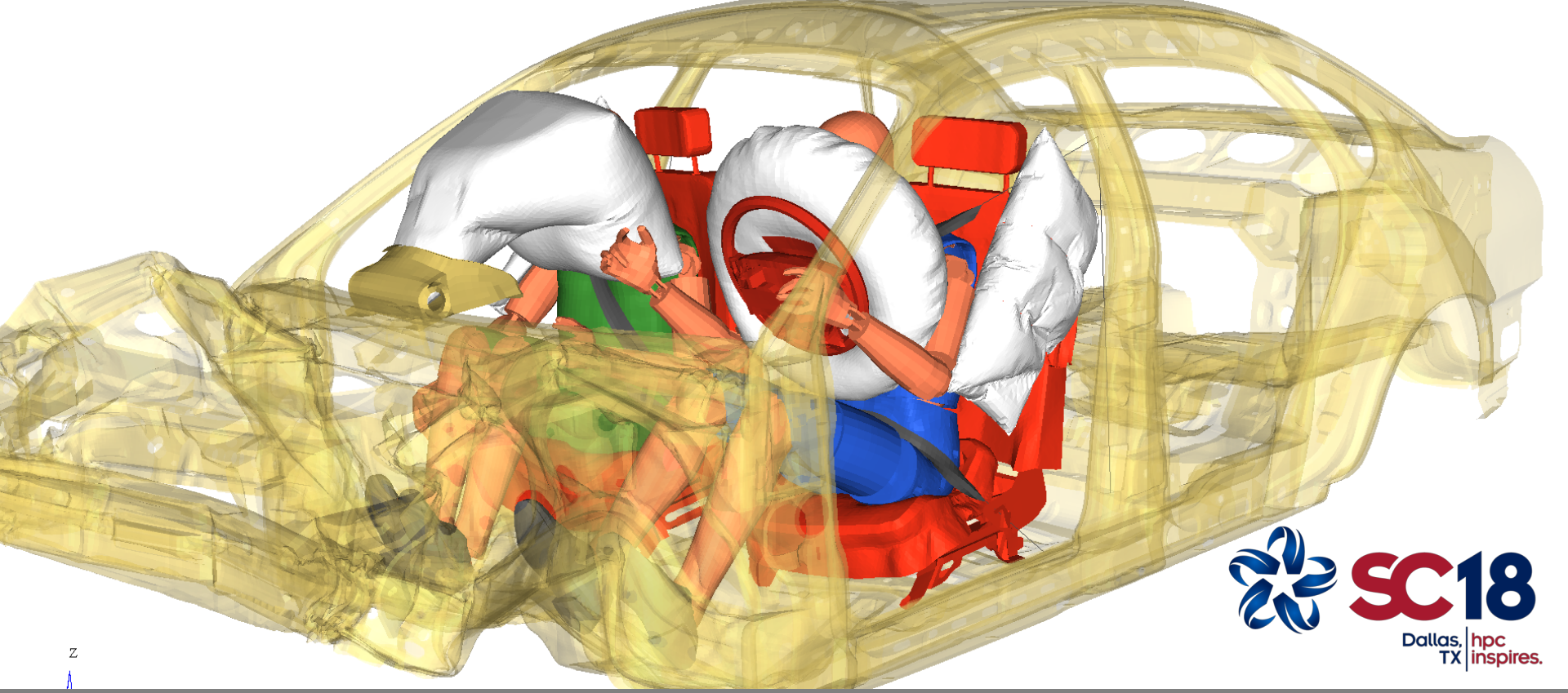


SC18
Dallas, TX | hpc inspires.

ALTAIR RADIOSS(TM)
ARM PORTING EXPERIENCES AND RESULTS

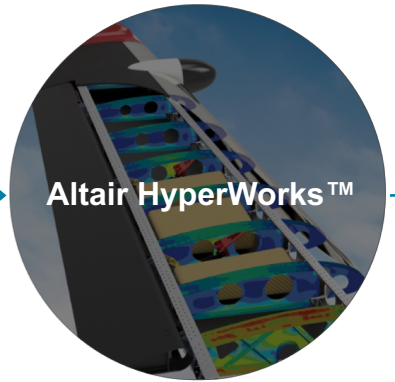
Eric LEQUINIOU VP Radioss Development & Altair Solver HPC

Altair

TECHNOLOGY FOR ALL PRODUCT LIFECYCLE STAGES

Simulation-driven Design

Rapidly create feasible and manufacturable product concepts for development

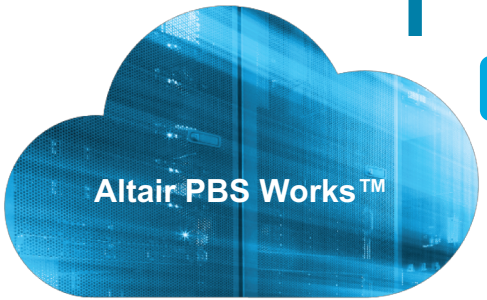


Multiphysics Optimization

Fully develop, optimize and validate high performance, lightweight products for production

Digital Twin

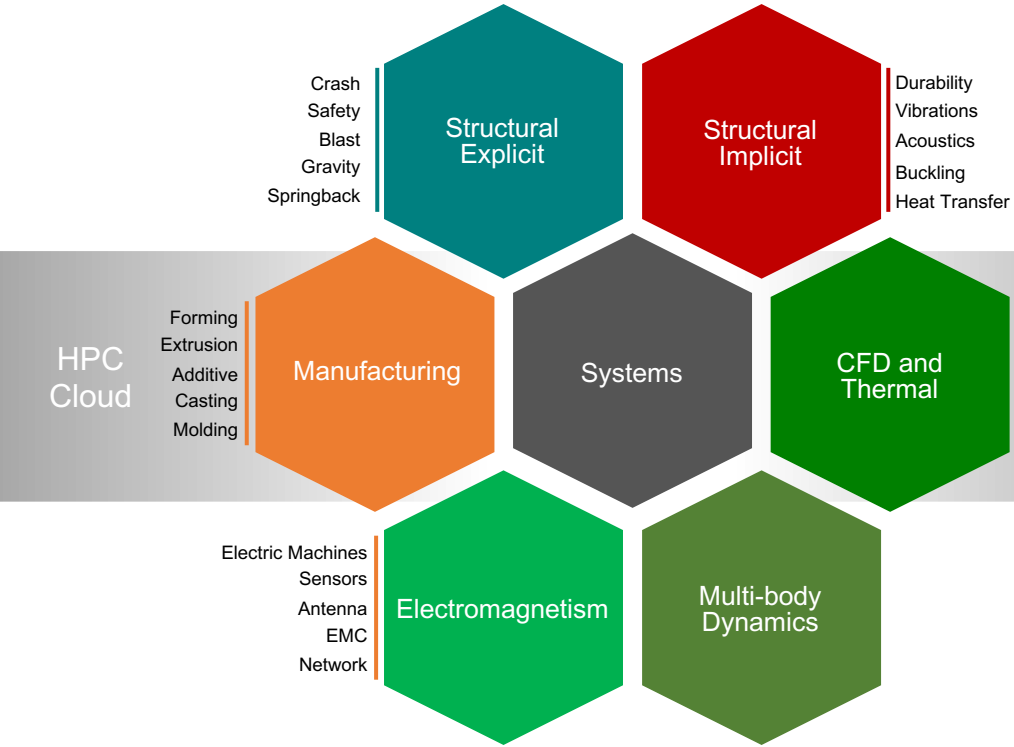
Easily connect, manage, and develop IoT applications for smart devices

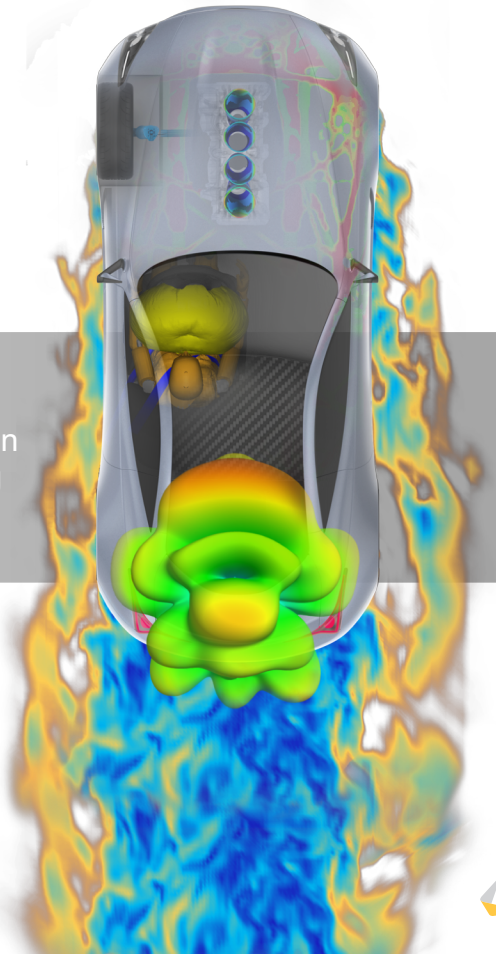


HPC Cloud Computing

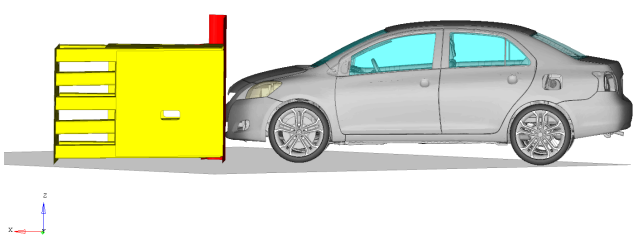
Connects users and administrators seamlessly with HPC resources to maximize utilization and efficiency

ALTAIR SOLVER TECHNOLOGY

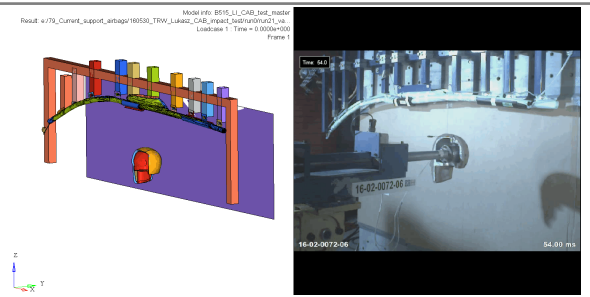




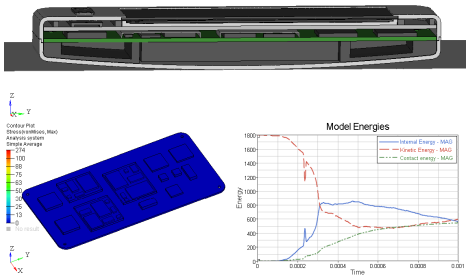
RADIOSS SOLVER



Crashworthiness



Airbags



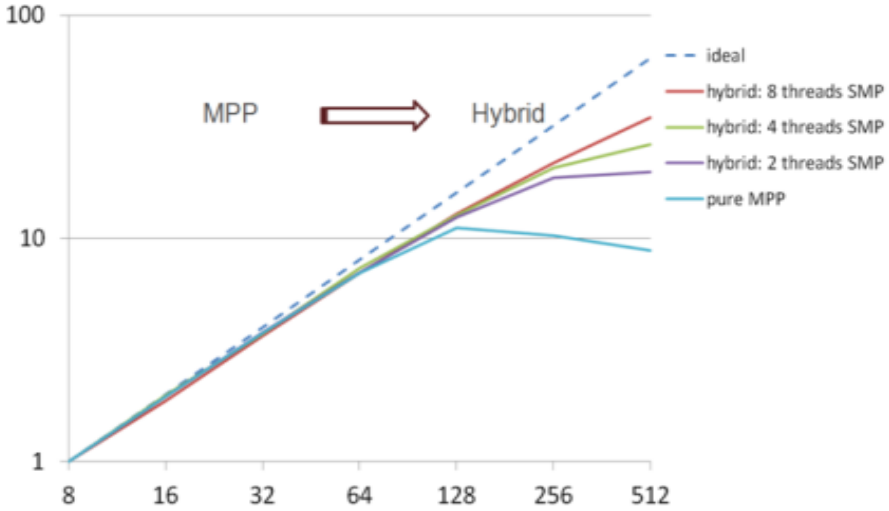
Contact

Multi-Physics

RADIOSS KEY TECHNOLOGIES

Highly parallel code with Hybrid model

- MPI Domain decomposition
- OpenMP parallelization
- Vectorization



Enhanced performance

- High efficiency on large HPC clusters
- Flexibility – easy tuning of MPI & OpenMP

Robustness

- Parallel arithmetic option for full repeatability (default)
- Double Precision (default)

MOTIVATIONS TO PORT RADIOSS ON ARM

Altair PBS Professional® already available on ARM

- Commercial release supports ARM (V18.2.1)
- Shipping with hardware partners' ARM-based systems (e.g., Cray and HPE)

Interest for the ARM architecture for Altair solvers

- Competitive performance results presented at last ARM UG
- Cost effective platform
- Be ready for future ARM based system deployments

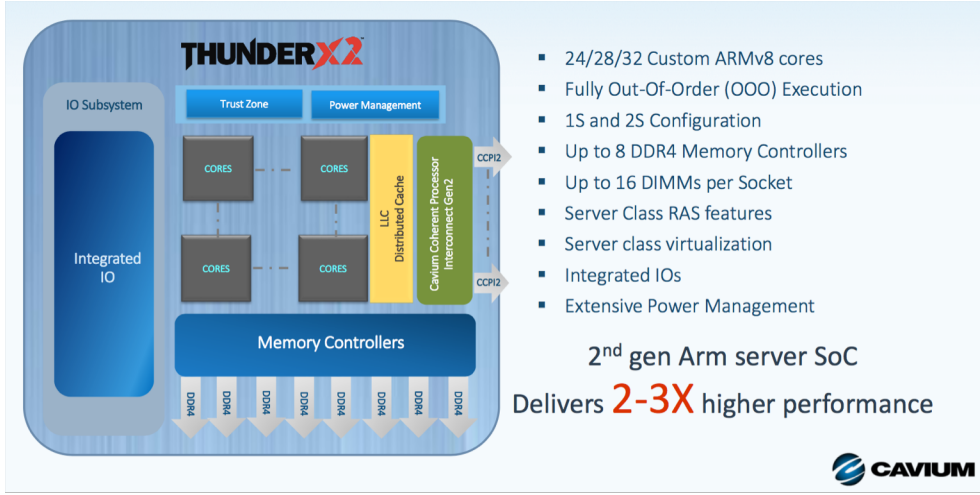
Choice of Altair Radioss

- Highly parallel code, MPI + OpenMP
- Explicit code (no need of external libraries)
- Vector code (SVE)
- POC pilot project for Altair HPC solver team

TEST SYSTEMS & PROGRAMMING ENVIRONMENT

- Cavium ThunderX2 (CN9975 v2.1) test machine at Altair
  - 2 Socket node with 2 x 28 cores @2,2 GHz (2.5 GHz max)
  - 8 memory channels per socket
  - 256 GB DDR4@2666MHz
- Programing Environment
  - Ubuntu 16.04.3
  - ARM Fortran compiler armflang 18.4.2
  - GNU Fortran compiler gfortran 7.1
  - OpenMPI 3.0.0
- Scalability tests on HPE Apollo 70 System
  - ThunderX2 CN9980: 2 x 32 cores @ 2.2 GHz (2.5GHz max) ; 256 GB DDR4@2666MHz ; 4 nodes
  - Mellanox IB EDR

arm



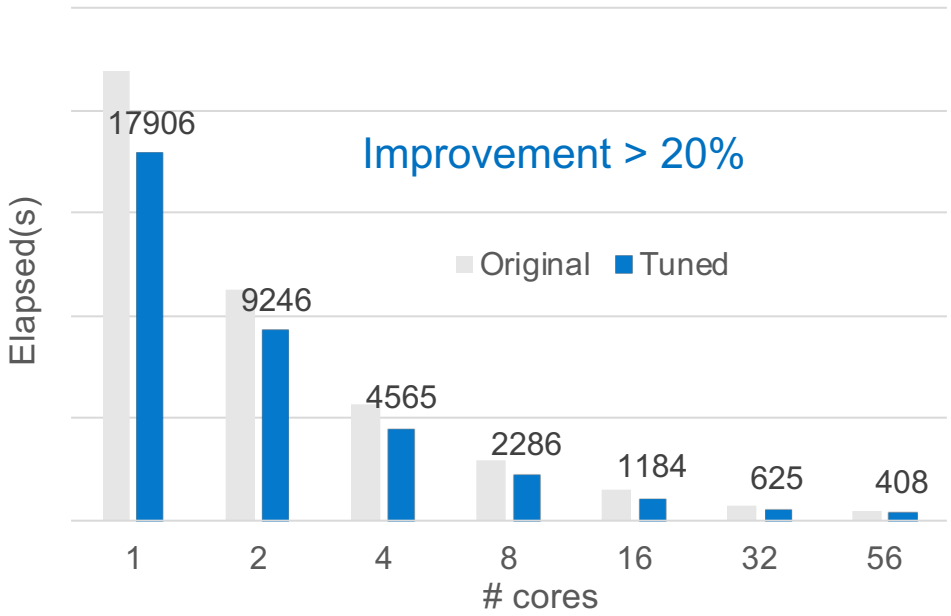
Hewlett Packard Enterprise

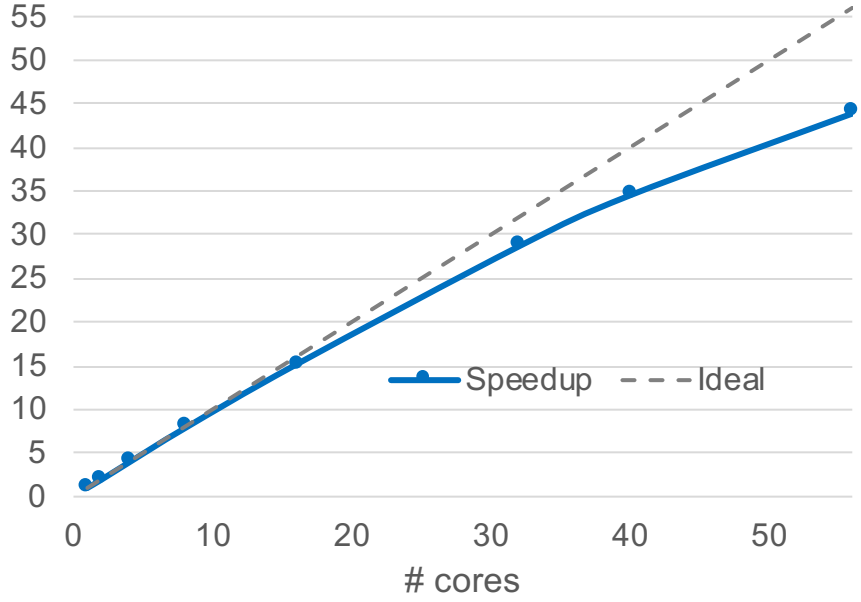
PORTING STEPS

- Armflang 18.1
  - First compilation, some issues and workarounds
- Armflang 18.2
  - Important fix for !$OMP CRITICAL and OMP_SET_LOCK/OMP_UNSET_LOCK
  - Important fix for numerical reproducibility issue
  - Additional minor fixes (line length extension,…)
- Armflang 18.4.1
  - Several minor fixes provided (I/O, pointers,…)
- Armflang 18.4.2
  - Performance improvement
- Additional tests with gfortran 7.1
  - Clean the OpenMP code to suppress !$OMP THREADPRIVATE for COMMON with EQUIVALENCE
  - No solution yet for numerical reproducibility at acceptable cost

FIRST PERFORMANCE EVALUATION ON SINGLE NODE

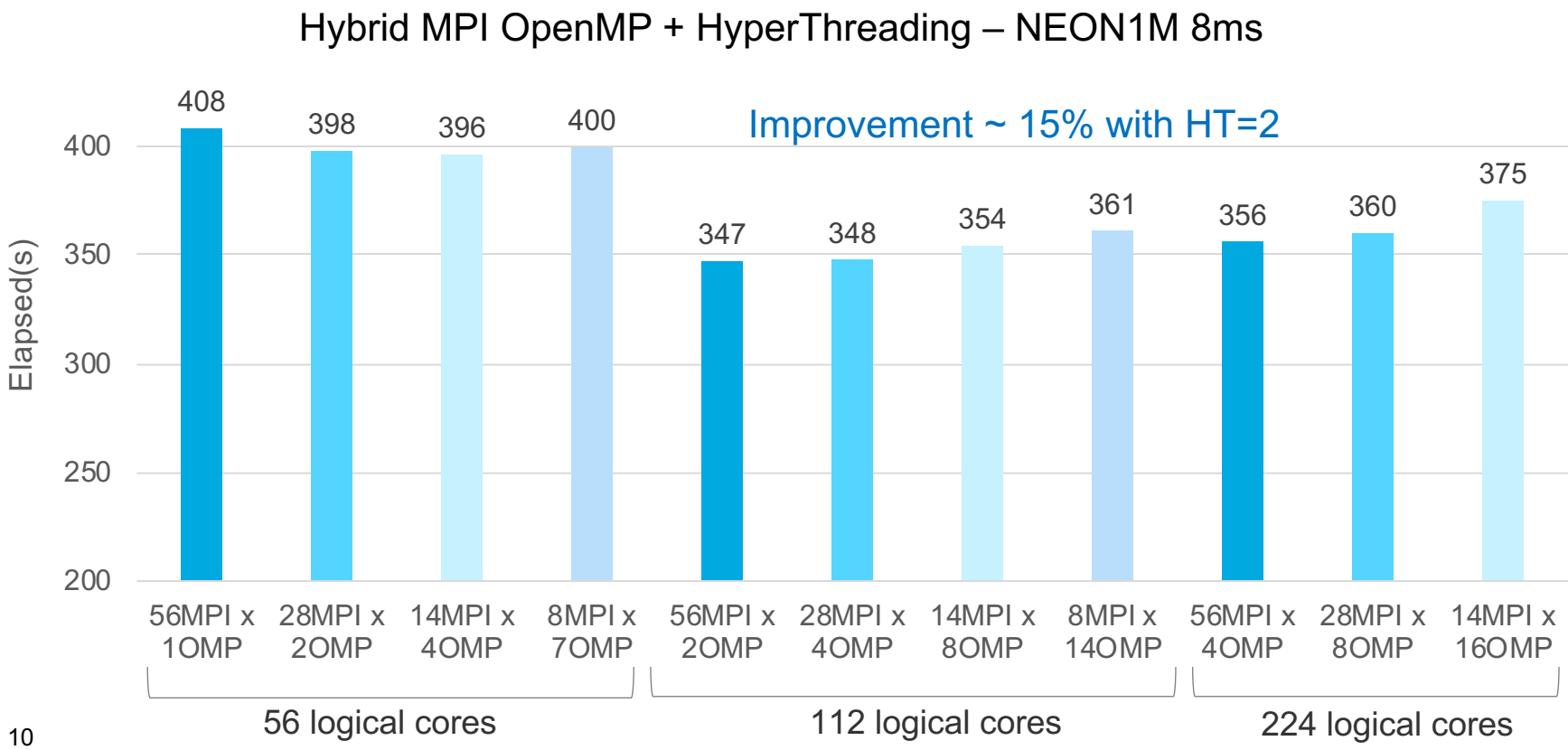
Pure MPI Performance & Scalability – NEON1M 8ms



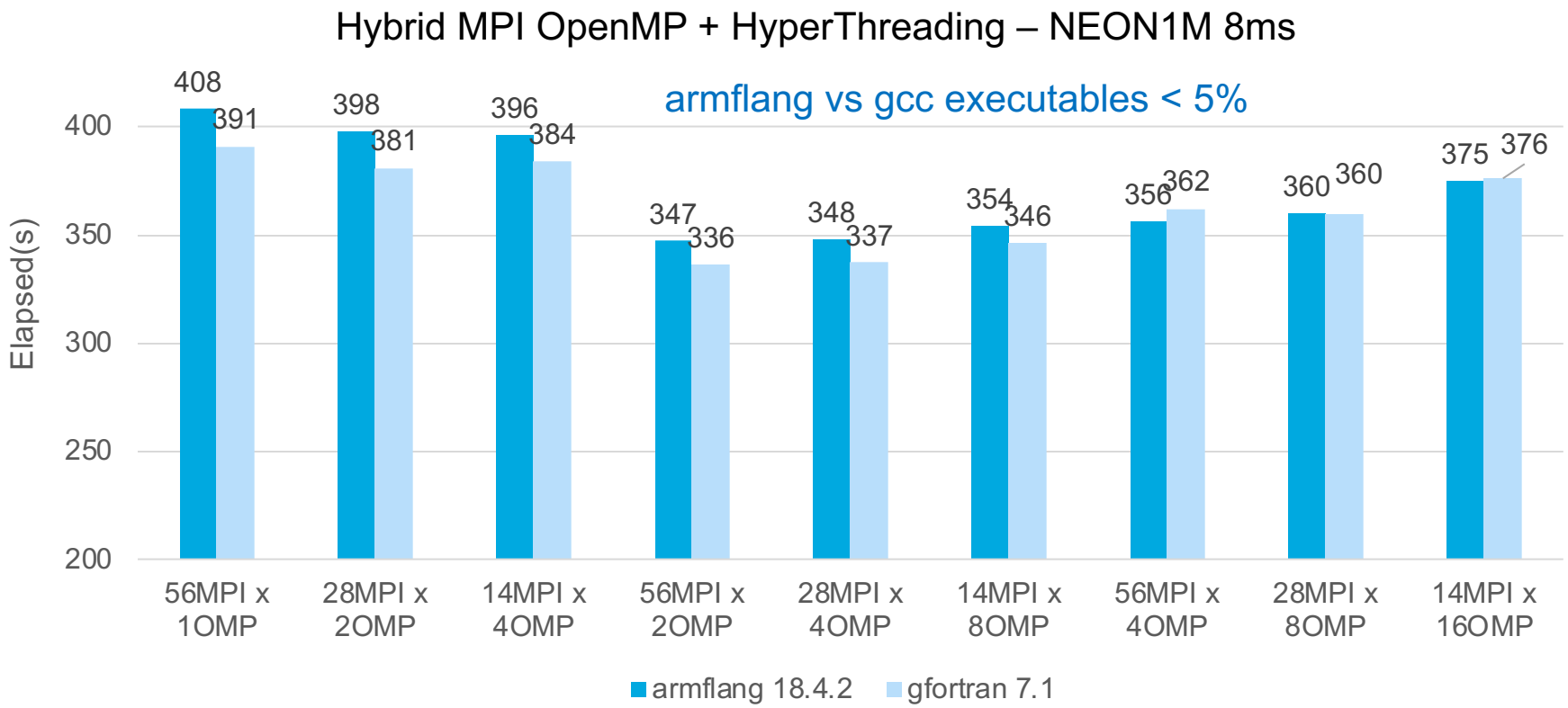


Excellent Scalability – Speedup = 44 over 56 cores

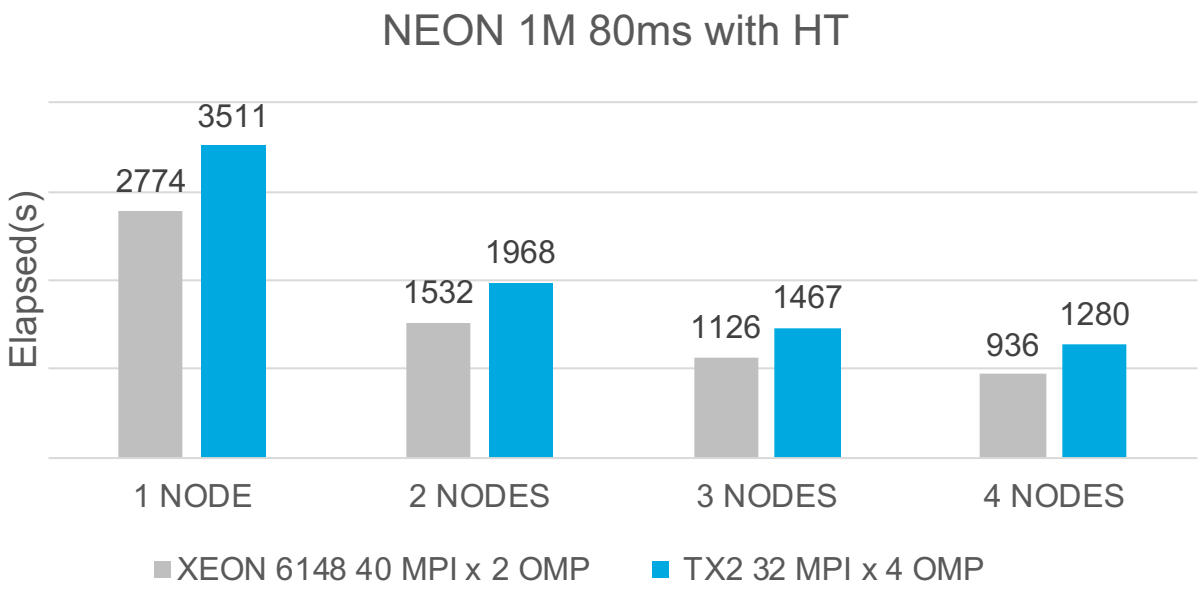
ADVANCED TUNING ON SINGLE NODE



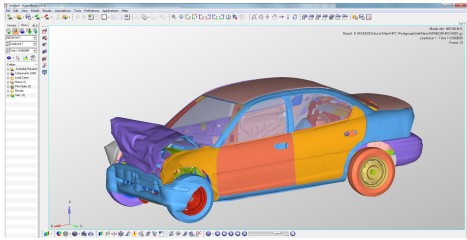
PERFORMANCE TESTS ARMFLANG 18.2.4 VERSUS GFORTRAN 7.1



CLUSTER TESTS ON HPE APOLLO 70 – 4 NODES THUNDERX2 CN9980



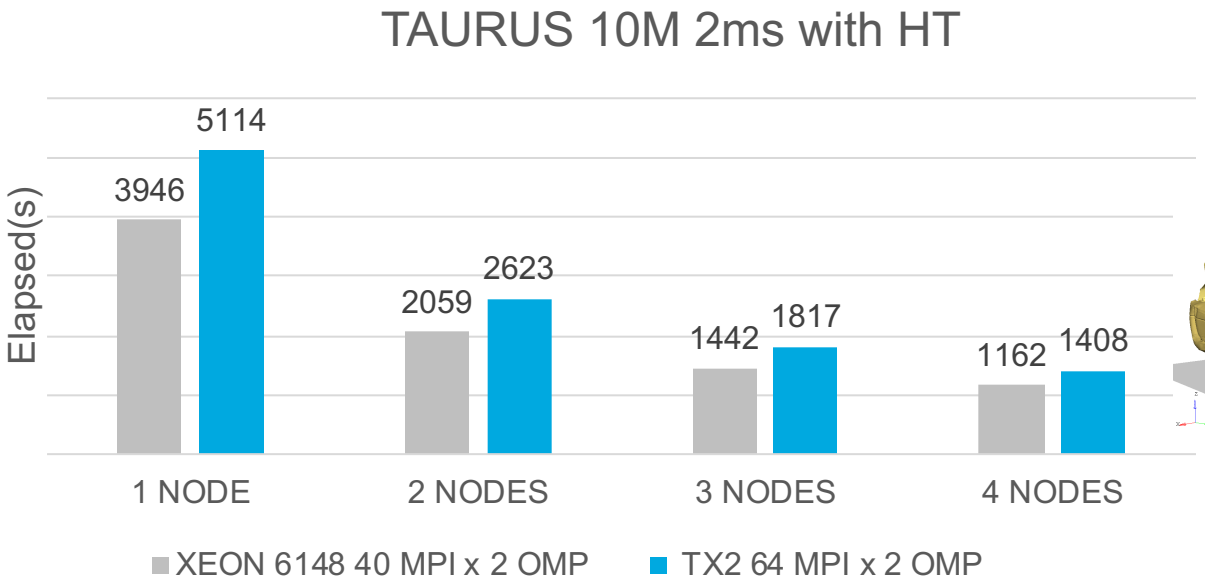
Hewlett Packard Enterprise

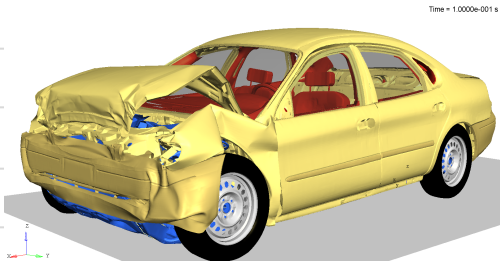


For this test, ThunderX2 CN9980 achieves 79% of the performance of the Intel Xeon* Gold 6148 on single node and 73% on 4 nodes

**HPE Apollo 6000 ProLiant XL230k Gen10 Server 2 x 20 cores @ 2.4GHz 192 GB 2666MHz DDR4 memory – Intel Omni-Path*

CLUSTER TESTS ON HPE APOLLO 70 – 4 NODES THUNDERX2 CN9980





For this bigger model, ThunderX2 CN9980 achieves 77% of the performance of the Intel Xeon* Gold 6148 on single node, and up to 83% on 4 nodes

**HPE Apollo 6000 ProLiant XL230k Gen10 Server 2 x 20 cores @ 2.4GHz*
192 GB 2666MHz DDR4 memory – Intel Omni-Path

CONCLUSION & OUTLOOKS

Successful POC

- Altair Radioss is running on ARM
- Very good scalability on single node
- HyperThreading with 2 threads per core gives an additional boost > 10%
- Promising results on cluster with 4 nodes

Next Steps

- Perform additional tests on larger number of nodes to better assess scalability under MPI
- Finalize QA and last issues solving
- Continue to work with ARM regarding performance improvement
- Collaborate with Cavium/Marvell, HPE and others to benchmark at scale
- SVE when available

A big Thanks for the very effective support from ARM, Cavium and HPE teams!

THANKS FOR YOUR ATTENTION!

SC18 Dallas, TX | hpc inspires.

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